



Argonne National Laboratory Process Engineering and Analysis Section, Energy Systems Division Advanced Metal Processes Research Program

Technology: The program focuses on advanced processes for the production, melting, and casting of metals. Metal inert anodes, bipolar electrodes, and wetted cathodes are used for aluminum production using our patented process. Iron production from ore or automotive shredder residue (ASR) fines has been demonstrated. Materials and processes for minimizing melt loss of aluminum and magnesium during melting that are based on maintaining a solid physical barrier between the molten metal and atmosphere have also been patented. Various processes for the manufacture of cost-effective magnesium castings are being developed in collaboration with the Magnesium Division of the American Foundry Society (AFS).

Facilities: For the electrolytic production of metals, several 10-Ampere cells and three 100-Ampere cells are currently operated in our section. A larger 1000-Ampere cell is being constructed for aluminum production. Cells are equipped for real-time off-gas analyses with in-line UV-vis and IR spectrometers or oxygen probes, and can be fitted with special traps for collection and subsequent analysis of chlorinated hydrocarbons (CHC) or other cell byproducts. For melting studies, we have two 1800°C furnaces, a 1600°C furnace equipped with a balance for in-situ weighing up to 5 kg, and several 1200°C furnaces. We also have access to the Advanced Photon Source and the Electron Microscopy Center at Argonne for performing detailed analyses of the electrolytic cell and melted materials. Magnesium casting projects are performed in collaboration with the AFS Magnesium Division. Molten magnesium is cast at industrial partner sites.

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Representative Projects:

- Inert Metal Anodes for Primary Aluminum Production – A new low-temperature electrolyte composition based on KF-AlF_3 enables the use of aluminum bronze anodes in the electrolytic production of aluminum.
- Magnesium electrolytic production – Minimization of chlorinated hydrocarbons (CHC) during the electrolytic production of magnesium from a chloride molten salt using carbon-based anodes.
- Molten Iron Electrolysis – Electrolytic production of carbon-free iron from iron oxide using a molten oxide electrolyte
- Iron Recovery from ASR – Production of value-added iron units from ASR fines.
- Melt Loss Reduction – Technology was developed for minimizing melt loss during aluminum and magnesium re-melting.
- Magnesium Castings – In collaboration with AFS, development of magnesium casting processes (e.g., lost foam, low-pressure permanent mold, low-pressure sand) for use in the transportation sector.